Impact Resistance Increment of Concrete by External Strengthening via Fibre Reinforced Polymers

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INTRODUCTION

- The reaction of concrete under impact has not been extensively studied and there is a gap of understanding about the behaviour of concrete under impact.
- Concrete piers on the motorways and highways are at risk from the vehicles and can seriously damage the structure, or can collapse the bridge completely. (Fig. 1)

Fig. 1 Damage of bridge due to vehicle collision [1].

- Fibre reinforced polymer (FRP) materials are being widely used from aeroplanes to helmets. Concrete industry has taken interest in FRP possibilities to protect and enhance the load-carrying properties of concrete (Fig 2.).
- FRP is one of the potential materials that can be used to strengthen concrete [2].

Why FRP ?

-Can be applied to any irregular surface,
-Easy to install without any special equipment,
-Short execution time,
-Less disrupt in use of the structure.

Fig 2. FRP Application.

OBJECTIVES

- To understand the behaviour and failure of concrete beams under impact loading using drop-weight tests considering the parameters of a drop-height and type of strengthening the material.
- Establish a finite element model with the help of simulation software to predict the behaviour of concrete under impact load and compare results with experimental results [Fig.3].

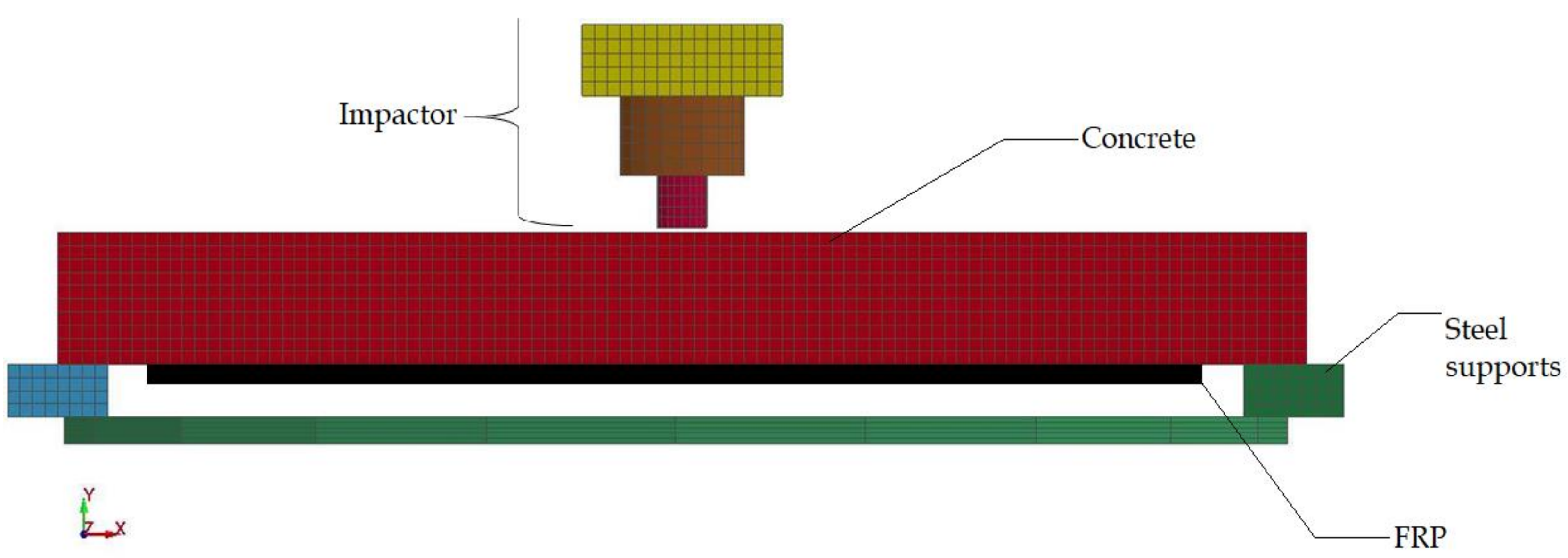

Fig. 3 Finite element model of beam impacted by drop-weight

SCHEDULED FIRST EXPERIMENTS

Twelve concrete prisms of size 500 mm x 50 mm x 50 mm, with or without carbon FRP strengthening will be casted as shown in Fig 3. Casting includes prisms of plain concrete and reinforced concrete.

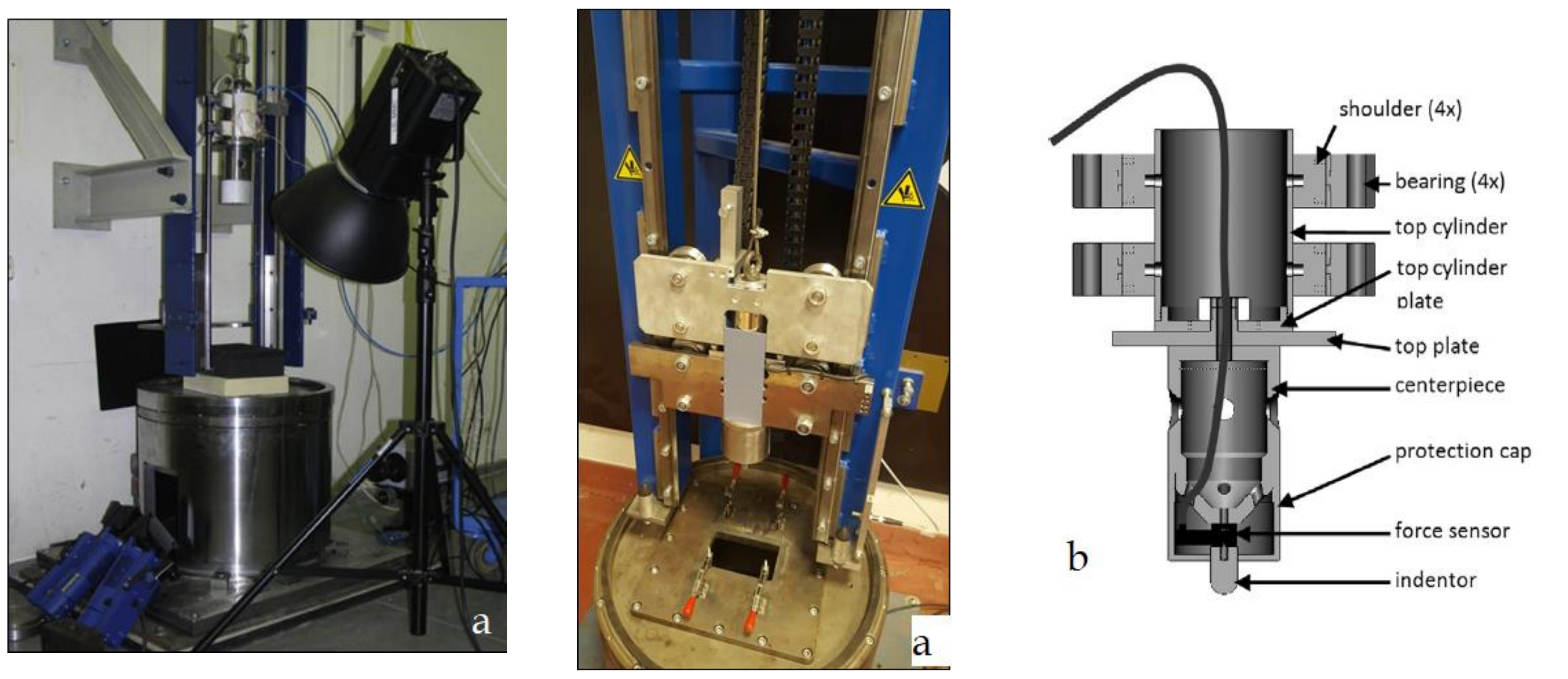

Fig.4 (a) drop-weight test setup (b) impactor parts.

The specimens are tested using a small-scale drop-weight test setup which consists of three parts (a) rigid support (b) impactor (c) guiding rails (Fig.4). The weight of the impactor is 7.64 kg. Failure of plain concrete by generally brittle, in this respect a high-speed camera will be used to observe cracking patterns of the concrete specimens.

NUMERICAL STUDY

A numerical model (FEM) created by two materials models i.e. concrete damage release 3 (MAT_72R3) for concrete and plastic kinematic material (MAT_3) for steel impactor & supports is used. Reaction loads are calculated using FEM model (Fig 5) with the help of multiple mesh sizes and are compared with experimental data taken from an existing study [3]. The numerical model shows promising results. Further calculations are going on.

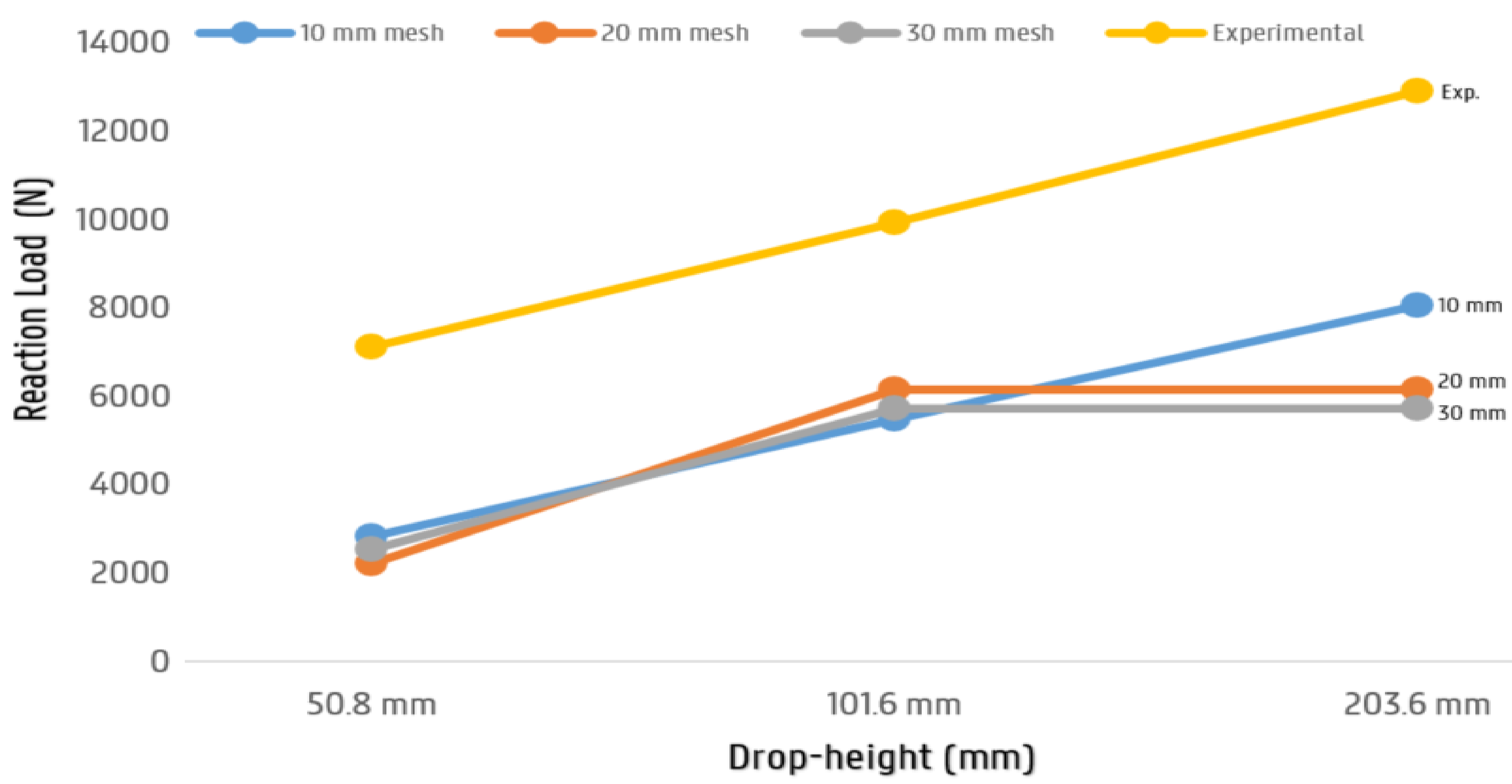

Fig.5 Reaction load of different drop-height and mesh size of concrete model.

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